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The Study of "Insects" in the Public Schools,

BY

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INTRODUCTION.

With a view to calling the attention of our worthy teachers to the great benefit and pleasure which may be derived both for themselves and their pupils by the introduction of the science of Entomology into the pupil's every day walks, and with the hope that it may contain some suggestions, which if put into effect, will enable the smallest school to have in its possession a good collection containing representatives of some of our most beautiful, and interesting forms of animal life, "insects," which will be an incentive to constant observation by the pupils, and illustrate to them some of the beauties of nature, this circular bulletin is issued.

While the science is correctly called Entomology, the word "Entomology" applies to a subject, and conveys to most minds the thought of its technical side, while the word "insects" applies to things, and is much simpler for the child to discuss. There is no doubt that we are constantly disregarding the well-known laws of the development of the child's mind, and the fact that in the growth of the intellectual faculties, the sense of perception must precede the formation of concepts, reasoning and judgment. While the laws of growth and development of all living things are practically the same, to the beginner, the difference between the members of the plant and animal kingdoms are so much more striking than their resemblances that representatives of each should be constantly brought to the attention of the pupil. In the attainment of this end, nothing will be found more profitable than the observation of the life and habits of insects.

In selecting representatives of these forms of animal life, the ease of obtaining and handling specimens, of keeping them alive, and watching their habits, are among the first important considerations. The abundance and convenient size of insects make it easy to study them. They can be found wherever man can live, and at all seasons. This abundance is even greater than is commonly supposed, when we remember that it is said that the insects alone comprise four-fifths of the animal kingdom. In addition, they have the advantage of presenting, while still retaining one general plan of structure, adaptations to almost all conceivable conditions of life. They live in the air, in the soil, on the water or beneath its surface. They feed upon plants or animals, as parasites either on the outside, or within the bodies of the latter; often they devour their own kind and themselves serve as an important element in the food of many animals. They exhibit the highest stage of perfection yet obtained by animals in the transformation of chemical energy and can do more work in proportion to their size than any other animal.

The method of reproduction not only presents the ordinary sexual forms, either by the production of eggs or by giving forth living young; but also the more unusual parthenogentic reproduction, or reproduction without fertilization. Further, nearly all insects in the course of their lives undergo remarkable changes in form. Thus the butterfly, which delights us with its airy flight, was at one time a caterpillar; the bee, which goes so busily from flower to flower, lived first the life of a clumsy footless grub; the graceful fly was developed from a maggot. These changes in their life history we denote as metamorphoses of insects.

Insects exhibit wonderful means of protection against their enemies, for animals of such small size. Claws, and still more effective stings supplied with poison, furnish them power of active defense. While others so closely resemble their surroundings in form and color that they deceive the sharpest eye. Some rely entirely for their safety on their extraordinary powers of locomotion by foot or wing.

Finally, the important relations of insects to man need only to be mentioned. For, while they are a great benefit to him in many ways, their activity in the destruction of his crops, or attacking his cattle or himself at times, causes him considerable apprehension.

Success in the study of insects will depend largely upon the skill displayed by the teacher or student in adapting the work to local conditions. Visit the forest, the orchard, the roadside and the pond, and the

observant student will find much to attract his attention, especially the different forms of insect life inhabiting each. Everything possible should be done to make this study a recreation which the pupils will enjoy outside of school hours. Let each have his own collection. Do not discourage the pupils by requiring them to memorize abstract statements concerning insects, but cause them to develop the power of accurate observation and of careful comparison. This should be the real source of their information. The development of the habit of ascertaining facts for themselves is one of the greatest benefits the pupils will derive from the study

COLLECTING INSECTS.

While much can be learned by merely watching insects in the field, in order to study them thoroughly it is necessary to collect specimens. In doing this we should be as humane as possible. While there is no doub that insects are not so sensitive to pain as are higher animals, they certain ly suffer to some extent when injured. Therefore they should be handled with great care, and killed without inflicting needless pain. Here we have a lesson which the teacher can impress upon the young minds, that of not being cruel to animals. As stated elsewhere, insects can be found almost anywhere. The pupils can collect them while going to and from school or at recess, but a class should be excused for an hour or two to make longer trips and should be accompanied by the teacher. The ideal time for collecting insects is on warm days when the sun is shining.

Collecting Outfit. A collecting outfit should consist of a cyanide bottle, a net, a few small vials, some containing alcohol, and three or four pill boxes for bringing home live specimens. In collecting butterflies great care must be exercised not to rub the scales from the wings. It is a good plan to carry along folded papers or small envelopes in which you can put the insects after they have been killed and thus carry them to the laboratory without mutilation.

Killing or Cyanide Bottles. Many chemicals can be used in killing insects without causing them to suffer to any extent and without mutilating them. By saturating a piece of cotton with either chloroform or sulfuric ether, and enclosing it with the insect in a tight box or bottle the desired effect will be secured. But the most convenient and common method is by the use of a cyanide bottle. These bottles should be prepared by the teacher or a druggist. Too much care cannot be observed in the handling of this chemical as it is one of the most deadly poisons known

If it is used according to the following instructions, however, no fear need be entertained. There are many ways of making a cyanide bottle, but the simplest is to take a wide-mouthed bottle holding from four to six ounces. Put in the bottle one or two pieces of cyanide of potassium about ½ inch in diameter or one piece about ¾ inch in diameter. Now fill the bottle about a third full of fine sawdust and pack down as solid as possible. Cut a piece of stiff cardboard in a circle, the diameter equal to that of the inside of the bottle, and put a little mucilage on the under side. Place this on the sawdust pressing it down well. You now have a cyanide bottle, which if properly taken care of, will retain its strength for months. Never leave the stopper out of the bottle for any length of time. After making a cyanide bottle be sure to label it *poison*. Always advise the pupils as to the deadly character of the poison, so that they will never touch the cyanide. Fig. 1 shows a four ounce bottle made with sawdust and cyanide as indicated. Another method of making a cyanide bottle is, after putting into the bottle the amount of cyanide of potassium as stated above, to add water enough to cover the chemical and immediately put in enough plaster of Paris to soak up the water. In this way the cyanide will be more firmly cemented in place in the bottom of the bottle than in the first method mentioned. A cyanide bottle about one-fourth of the size of the one described above is useful to carry around in one's pocket constantly during the collecting season, see Fig. 2. Insects to be killed should be left in the bottle at least a half hour, but allowing them to remain longer, or even over night will not injure them.

FIG. 1.

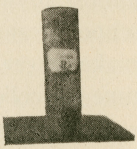

FIG. 2.

Insect Nets. While a net is not necessary to capture insects, it is advisable in order to catch a number of the members of the class which are strong jumpers or flyers. The form of net shown in Fig. 3 is usually employed. This can be made by taking a piece of No. 3 galvanized iron wire and bending into a ring about a foot in diameter. The ends of the wire should be twisted and tightly fastened to a light wooden handle such as is fitted to a broom. The ring should be covered with a strong piece of unbleached linen, and to this is sewed a bag made of strong cheese cloth, about two feet long, being the diameter of the ring, where it is sewed on, and tapering slightly towards the bottom. The bottom of the net should be rounded, and without corners or points in which the insects

can lodge. This net can be used in catching insects flying in the air, and also those that rest on the grass, weeds, etc.

FIG. 3.

Vials and Pill Boxes. It is always well to have a few vials and pill boxes along on a collecting trip, in which you can place small, delicate insects alive or dead ; especially are they useful in carrying home living specimens of adults, pupæ or larvæ. In collecting soft-bodied insects and spiders it is best to have two or more vials filled with alcohol.

Paper Envelopes. This is what is referred to elsewhere in mentioning the manner in which lepidopterous insects may be carried. After killing the specimen by pinching the thorax, it is dropped into an envelope, such as a small drug envelope or the larger pay-roll envelope, which can be bought for a comparatively small sum at any stationers. In this way the insects can be carried in a small flat box without danger of breaking any of their parts. If the specimens are kept for any length of time in this manner they should be moistened by placing on damp

sand before handling. It is hardly necessary to secure envelopes, however, if you can provide yourself with a very large cyanide jar prepared as the cyanide bottle, as the butterflies and moths can be put into the jar without danger of injury.

HOW TO COLLECT INSECTS.

With the above apparatus the collector can start out almost anywhere in the warm season of the year, and if on the alert he will see numbers of insects. One should go slowly, examining all herbage, foliage of shrubs and trees, and he will observe many tricks of the insects. He should use his net in catching active insects, but in collecting generally the net is also used for what is commonly called "sweeping." This consists in passing the net to and fro about two feet in front of you over the grass and herbage. The net must be turned at the end of each stroke, and must be kept in rapid motion so that the insects cannot escape from it. When a large number of specimens have accumulated in the net they should then be transferred to the cyanide bottle.

An excellent method of taking specimens at night is to open the window close to a light. In this way it will be found that many insects can be captured which one will never see during the daytime. The method known as "sugaring" is also practiced at times. This consists of smearing, with a solution, of paint consistency, made of molasses and stale beer, the trunks of trees on the edge of the woods or in a yard surrounding a house, or it may be applied anywhere to fences, that are likely to be surrounded by insects at night. The solution should be applied about sunset, on the places designated, in strips about two inches wide and several inches long. These patches of sweet solution will attract nocturnal insects, especially moths, and the collector can visit these baits after dark and there will be found hovering about them on the trees and fences many specimens which he can easily trap.

THE BREEDING OF SPECIMENS.

The best method of obtaining perfect specimens is by breeding them. Especially is this true with moths and butterflies. They do not have a chance to mutilate themselves, and also there is no danger of the collector's injuring any of their parts. Although breeding insects involves a good deal of labor and care, it affords a most delightful field

for observation in the school, and the returns are frequently of great value. A point to be emphasized is, that in collecting insects and larvæ for the breeding cage one should observe the kind of food they eat when unmolested, as it is necessary to furnish them with an abundance of this food when they are confined. If they live in water, determine whether they will require running water or can be kept in an ordinary aquarium.

The boxes, suggested as a part of the collector's apparatus, are used principally to carry such specimens as he wishes to keep alive in the school or laboratory.

Breeding Cages. There are a great many kinds of breeding cages, but it is only necessary to cite the simplest in this discussion. This is represented in Fig. 4. It is made by combining a flower pot and a lantern globe. If convenient, the food plant can be planted in the pot; or, if not, a small tin or bottle filled with water may be placed in the earth and the stems or other material can be kept fresh for a time by keeping the lower ends in water. The top of the globe should be covered with fine mosquito netting which can be held in place by either a string or a rubber band. Of course larger pots and correspondingly large glass cylinders as represented in Fig. 5 may be used. These pots are readily moved from place to place and are especially convenient for watching the insects confined.

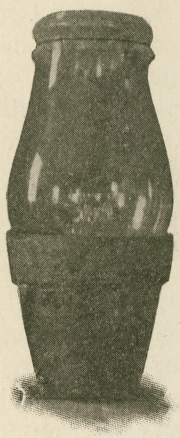

FIG. 4.

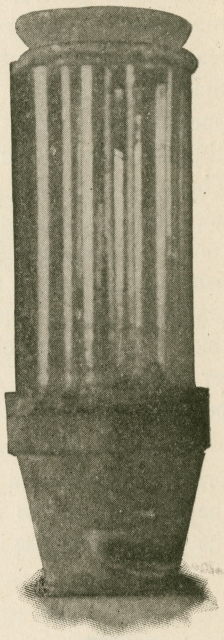

FIG. 5.

Aquaria. For keeping and breeding aquatic insects some form of an aquarium is needed, but it need not necessarily contain running water. Of course, if such is convenient, it is very desirable. Any ordinary jar can be used. It is a good plan to keep some kind of water plants in the jar, as the water will be kept in a better condition and it will not be necessary to change it so often.

THE PRESERVATION OF SPECIMENS.

After a collecting trip, specimens collected should be mounted immediately, as they can be handled more easily then than at any other time. All insects that will preserve their forms when dry should be pinned, with specimens of their nests or work, mined or rolled leaves, or other similar objects. Immature forms of all insects, adult insects which have soft bodies, or specimens intended for anatomical study, should be preserved in alcohol or some other preserving fluid. Some insects of minute size should be mounted in Canada balsam upon slides.

Insect Pins. There are many styles of insect pins employed, but those used generally by American entomologists are known as German pins. They are rather long and slender, and are preferred for this reason, as they keep the specimen higher from the bottom of the box than ordinary pins. It is also desirable to use these pins ; for if shorter ones are used, and at any time one should wish to change specimens, some difficulty would arise on account of the difference in the size of the pins. These German pins are made in different sizes of wire and are numbered accordingly. It is left to the judgment of the collector what size to use for the different sized insects. They can be purchased from any establishment dealing in entomological supplies. If it is not possible for the teacher to secure these pins, the common brass pins which are somewhat thicker and shorter can be used. The ordinary mourning pins have better points than the common brass pins and may be preferable for this purpose, especially when cork or pith is not used in insect cases.

Pinning Specimens. In a properly arranged collection it is of prime importance in pinning specimens to have them uniform both as to the position of the insect on the pin, and also the place of inserting the pin through the insect. A good rule to remember in pinning most insects, is to project the pin through the middle of the thorax of the insect. There are exceptions to this rule, however, especially in the case of beetles, which should be pinned through the right wing cover, at about one fourth of its length from the base as shown in Fig. 6, and also in pinning what we may call bugs (order *Hemiptera*), which should be pinned through the scutellum, the triangular plate on the back.

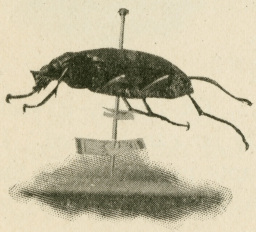

FIG. 6.

In order to secure uniformity in the position of insects on the pins, a device shown in Fig. 7 is convenient. This consists of three small strips of wood one fourth as thick as the pins are long and fastened together as shown. A hole just large enough to allow the passage of the head of the insect pin in use is bored through the center of each step of the block. In pinning an insect, the pin is pushed through the insect so that less than one fourth of its length projects above it, and the insect is pushed back into the proper place by inserting the head of the pin in the hole in the lower step of the block. This step and the second is used in fixing the height of insects mounted on cardboard tips.

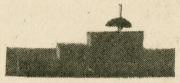

FIG. 7.

When it is wished to pin an insect which is too small to pass a pin through and which is not desired mounted on glass slides, the insect may be stuck, by means of a small amount of muscilage, to pointed pieces of cardboard as shown in Fig. 8.

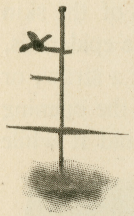

FIG. 8.

Much more attention is necessary in pinning the members of the order *Lepidoptera*, or moths and butterflies, than other insects. As stated elsewhere care must be exercised in handling them so as not to rub the scales off their wings. After the pin has been thrust perpendicularly through the thorax, the insect should then be placed in a setting board. Setting boards are pieces of wood having a groove on the upper surface of sufficient depth to accommodate the body of the insect and to permit its wings to be brought on a level with the upper surface of the board as shown in Fig. 9. On the bottom of the groove should be tacked a piece of cork or pith into which the pin inserted through the insect may be thrust down below its body for a considerable distance, to hold it steady. There should be uniformity in arranging the wings. After the wings are put in position and held there by narrow slips of paper, wider slips of paper or mica are laid on the wings and pinned down. For this purpose sharp pointed mourning pins are better than the ordinary brass pins. In pinning down the slips of paper or mica which are to hold the wings

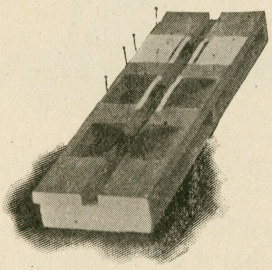

FIG. 9.

in place, be careful to pin around the wing, but never, if possible, through it. The specimens should be left in this manner for from three to six days, or until the wings will hold their positions when the mica or paper is removed. The wings of other insects may be spread in the same manner.

Inflating Larvæ. While the larvæ of insects are usually preserved in alcohol, it is often wished to pin the specimen in the regular collection with the adult. In order to do this the larvæ must be inflated so that it will not decay. In inflating the larvæ the first step, after killing it in a cyanide bottle, is carefully to remove the contents of the skin. This is done by inserting a stout pin or needle into the anal extremity. Lay the specimen on a sheet of paper, and, placing a pencil across it just back of its head, press out the contents of the abdominal cavity. Care must be exercised to apply only enough pressure to expel the contents of the skin without mutilating any of the tissues which lie nearest to the epidermis, or the hairs which may be attached to the body. Now insert a straw, or glass tube, previously heated, in the anal opening and close the opening perfectly with glue or colodium if necessary, and inflate, hold it while inflated in a hot place to dry. A convenient method of drying it is in an oven made by laying a large lamp chimney across a tray of sand over a lamp. (See Fig. 10.) Hold the specimen in the heat until thoroughly dry, but in drying the skin care must be exercised not to heat it so much as to destroy the colors. When the skin is dry remove it from the tube and mount it on a piece of copper wire, wrapped in green silk, which has been bent around a small piece of cork, through which insert an insect pin. The wires are bent and twisted together for a short distance and then made to diverge as shown in Fig. 11. An inflated larvæ mounted is illustrated in Fig. 12.

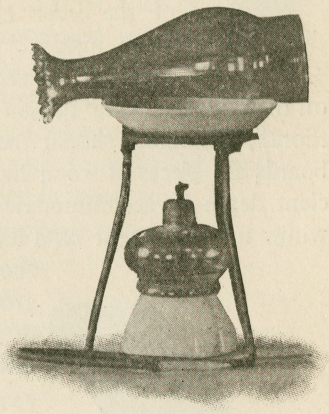

FIG. 10.

Labeling Specimens. It is very important in making a collection of insects, to label carefully each specimen, so that it will be possible at any time to tell when and where each one was collected. Moreover, if there is any other data of observation made concerning the insect, it

should be recorded in such a way that there can be no doubt of the specimen to which it refers. While it is not practical to give each specimen

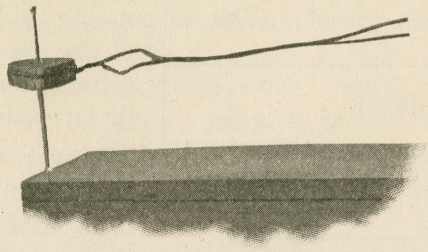

FIG. 11.

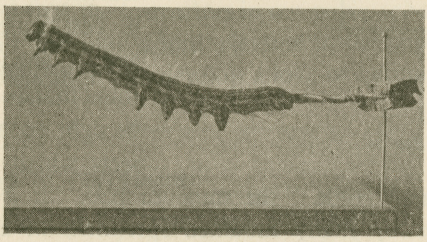

FIG. 12.

a different number, you can give each species a different number. The label shown in Fig. 13, we find to be useful and practical. On these are shown the location, the date of collecting specimen and the accession number. This accession number refers to an accession book in which there are corresponding numbers and in which is written such data as is obtained concerning the specimens. These lables can be printed at a small expense, or they can be written; but it is best to have them as small as possible. Another label containing the generic and specific name of the insect should be attached to each specimen. In arranging specimens in a permanent collection, labels should be placed at the head of each group indica-

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Fig. 13.

ting the order, family and genus. The size of the labels generally used for each respective classification is shown in Fig. 14. The labels are generally printed in red ink. This will not only add to the appearance of the collection but will be useful in looking up any particular specimen.

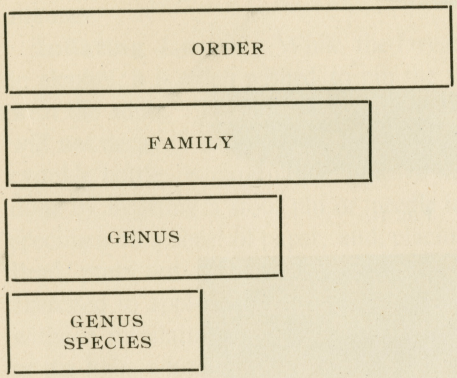

FIG. 14.

Insect Cases. It will not be practical to discuss the many forms of insect cases employed. It is left to the teacher to select the one that is best suited to his needs. But it should be borne in mind that an insect case should be tight so as to exclude insects which may prey upon their kind. A small beetle "the museum pest," if it gain access to a collection, will destroy many mounted specimens in a short time. If this pest should appear, its work being detected by the small amount of dust under each specimen, or by examining the specimens closely and observing that they are being mutilated, the case should at once be fumigated with carbon bisulphide by pouring a small amount of the liquid in a watch glass or other small vessel and placing this in the case, and keep the latter closed for several hours. By continuing this practice the pest will be eradicated. For temporary use, and especially when it is desirable to avoid unnecessary expense, cigar boxes can be procured in which the insects can be pinned. Although these are convenient to use, if a teacher or pupil desires to make a permanent collection, some kind of insect case should be employed for the reason given above. A case such as is shown in Fig. 15 is very convenient at times. It is about 12 inches long, 9¼ inches wide, and 3⅝ inches thick, made as illustrated in cut, so it will close tightly. A case of this character will hold a large number of insects as they can be pinned in both top and

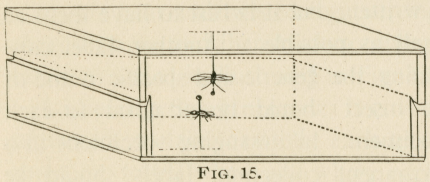
FIG. 15.

bottom as shown. Thin cork, which is covered over with paper, is placed in both top and bottom in which the pins may be projected.

The methods of collecting and preserving insects given in this circular are recommended by Prof. J. H. Comstock, one of our leading entomologists, in his book entitled "Insect Life," which, with Comstock's "Manual of Insects," the writer commends to every teacher and pupil working with these interesting forms of animal life.

Any specimens sent to the Entomological Department, Maryland Agricultural College, College Park, Maryland, will be gladly determined and any information desired will be given. It is our wish that each school in time may have a permanent collection of insects.

It is to be hoped that the instructors in our public schools will foster this science, which will not only afford pleasure to the pupils, but will train their power of observation and develop a love of nature.

To the Teachers of Maryland:

We are sending out at this time three pamphlets bearing upon nature study. We trust that these little messengers of our good will will find you deeply interested in the work. Certainly efforts expended, in equipping the young with the means of finding an intellectual interest in future surroundings, must be most gratifying to those who lend themselves to the task. If you are a teacher in a rural school are you not astounded at the ignorance of the children of the simple effects and causes which are constantly operating around them? How different each day would be in its quantum of pleasure, if the eyes could see, if the ears could hear and the mind could understand that hidden in everything that exists is the principal that vitalizes its being. Seeing and knowing these principles lifts life above drudgery and makes any calling a pleasant vocation. Now our mission is to give our pupils just this power. Could our task be a nobler one? We wish to lend you all the instrumentalities of this institution to the accomplishment of this one end. Will you not accept them and thus aid in the great work which is arousing so much interest in every part of our country? We believe that you will.

Fraternally yours,

R. W. SILVESTER,

President of the Maryland Agricultural College.